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# ERRATUM: “H<sub>2</sub> FORMATION ON GRAIN SURFACES” (2004, ApJ, 604, 222)

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As noted by Bai & Goodman (2009), the equations for the transmission coefficients to go from a site  $i$  to a site  $j$  in Cazaux & Tielens (2004) erroneously omitted a key factor and also contained a typo. The correct equations are

$$T_{ij}^{(1)} = 4 \times \sqrt{\frac{E - B_{ij}}{E}} \left[ \left( 1 + \sqrt{\frac{E - B_{ij}}{E}} \right)^2 + \frac{B_i B_j \left( \sinh \left( \sqrt{\frac{2m(B_i - E)}{\hbar^2}} Z \right) \right)^2}{(B_i - E)E} \right]^{-1} \quad \text{if } E < B_i, \quad (1)$$

$$T_{ij}^{(2)} = 4 \times \sqrt{\frac{E - B_{ij}}{E}} \left[ \left( 1 + \sqrt{\frac{E - B_{ij}}{E}} \right)^2 - \frac{B_i B_j \left( \sin \left( \sqrt{\frac{2m(E - B_i)}{\hbar^2}} Z \right) \right)^2}{(B_i - E)E} \right]^{-1} \quad \text{if } E > B_i. \quad (2)$$

These equations differ from Equations (1) and (2) of the original paper in the additional factor  $\sqrt{\frac{E - B_{ij}}{E}}$ , which is the ratio of the transmitted over the incident wave numbers, with a change of variable in order to define the energy  $E$  as being zero at the bottom of the potential well  $i$  (e.g., for  $T_{PC}$ , the energy of the atom is defined from the physisorbed site). The relevant energies  $B_i$ ,  $B_j$ , and  $B_{ij}$  are summarized in Table 1 where—compared to the original paper—a small typo in the expression for the  $B_{ij}$  has been corrected as well. Note that  $B_{ij}$  is negative with these definitions and the omitted factor can greatly increase the values of the transmission coefficient for an H atom to go from a physisorbed site to a chemisorbed site. As a result, the probability for a physisorbed H atom to become chemisorbed increases. By the same token, the H<sub>2</sub> formation efficiency will also increase. Using the parameters for the potential energy curves as described in Figure 15 of Cazaux & Tielens (2004), Figure 1 shows the corrected efficiencies for H<sub>2</sub> formation on olivine and carbonaceous surfaces. For grain temperatures higher than 25 K, these efficiencies are  $\sim 3.5$  times higher than without the correction. For lower temperatures, where H<sub>2</sub> formation from physisorbed H atoms dominates, the efficiencies remain unchanged.

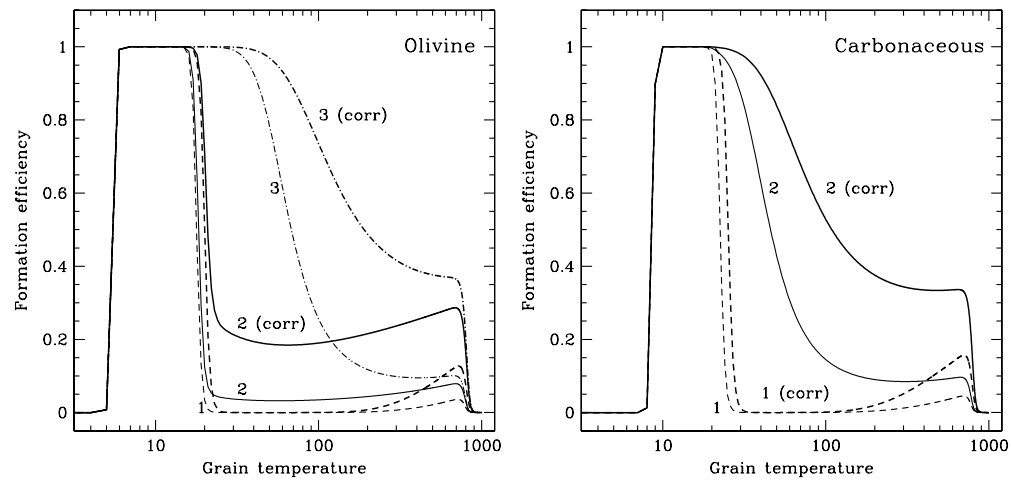
**Table 1**  
Parameters Used to Calculate the Transmission Coefficients

$T_{ij}$	$B_i$	$B_j$	$B_{ij}$	$Z$
$T_{PP}$	$E_P(k) - E_{SP}$	$E_P(k) - E_{SP}$	0	$A$
$T_{CC}$	$E_C(k) - E_{SC}$	$E_C(k) - E_{SC}$	0	$A$
$T_{PC}$	$E_P(k) - E_S$	$E_C(k) - E_S$	$E_P(k) - E_C(k)$	$a$
$T_{CP}$	$E_C(k) - E_S$	$E_P(k) - E_S$	$E_P(k) - E_C(k)$	$a$

The general expressions for the H<sub>2</sub> formation efficiency obtained in Cazaux & Tielens (2002, Equation (9)) and Cazaux & Tielens (2004, Equation (19)) remain valid. However, the expression for  $\alpha_{PC}$  is calculated from the transmission coefficients that were previously underestimated. Therefore, the corrected expression for  $\alpha_{PC}$  is

$$\alpha_{PC} = 8\sqrt{\pi T} v_{H_P} \frac{\sqrt{E_{H_C} - E_{H_P}}}{E_{H_C} - E_S} \exp \left( -2a \frac{\sqrt{2m_H k_B (E_{H_P} - E_S)}}{\hbar} \right) + 4v_{H_P} \sqrt{\frac{E_{H_P} - E_S}{E_{H_C} - E_S}} \exp \left( \frac{-(E_{H_P} - E_S)}{T} \right), \quad (3)$$

where the first term is the mobility through tunneling and the second term through thermal hopping. In the original paper, the tunneling term was not taken into account because tunneling was only important at low dust temperatures and, for those conditions, direct recombination of physisorbed atoms dominates H<sub>2</sub> formation. With the corrected expression, this term has to be taken into account.



**Figure 1.** Efficiencies of  $\text{H}_2$  formation as calculated in the original paper (thin lines) and corrected from the factor (thick lines, also marked as corr). Each line represents a different barrier from a physisorbed site to a chemisorbed site (see Figure 15 in Cazaux & Tielens 2004).

We are grateful to X.-N. Bai for pointing out this error and to A. Glassgold for alerting us to the importance of this error.

## REFERENCES

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